

Shortwave surface flux trends from satellite and surface site data: Preliminary results from GEWEX-RFA

Laura Hinkelman¹

Taiping Zhang²

Betsy Weatherhead³

Paul Stackhouse⁴

Bruce Wielicki⁴

¹National Institute of Aerospace, ²Analytical Services & Materials, Inc.,

³CIRES, University of Colorado, ⁴NASA Langley Research Center

Background

**Numerous reports of “global dimming” or “brightening”.
20 years of surface flux estimates from satellites now available.**

Questions:

What are worldwide trends?

Are surface site measurements representative of global view (both values and trends)?

⇒ Look at data from GEWEX-SRB and GEBA.

GEWEX Surface Radiation Budget (GEWEX SRB)

Based on ISCCP clouds and radiances.

Produced at 1°x1°, RFA version at 2.5°x2.5°

Version 2.5: July 1983 -- December 2004

Global Energy Balance Archive (GEBA)

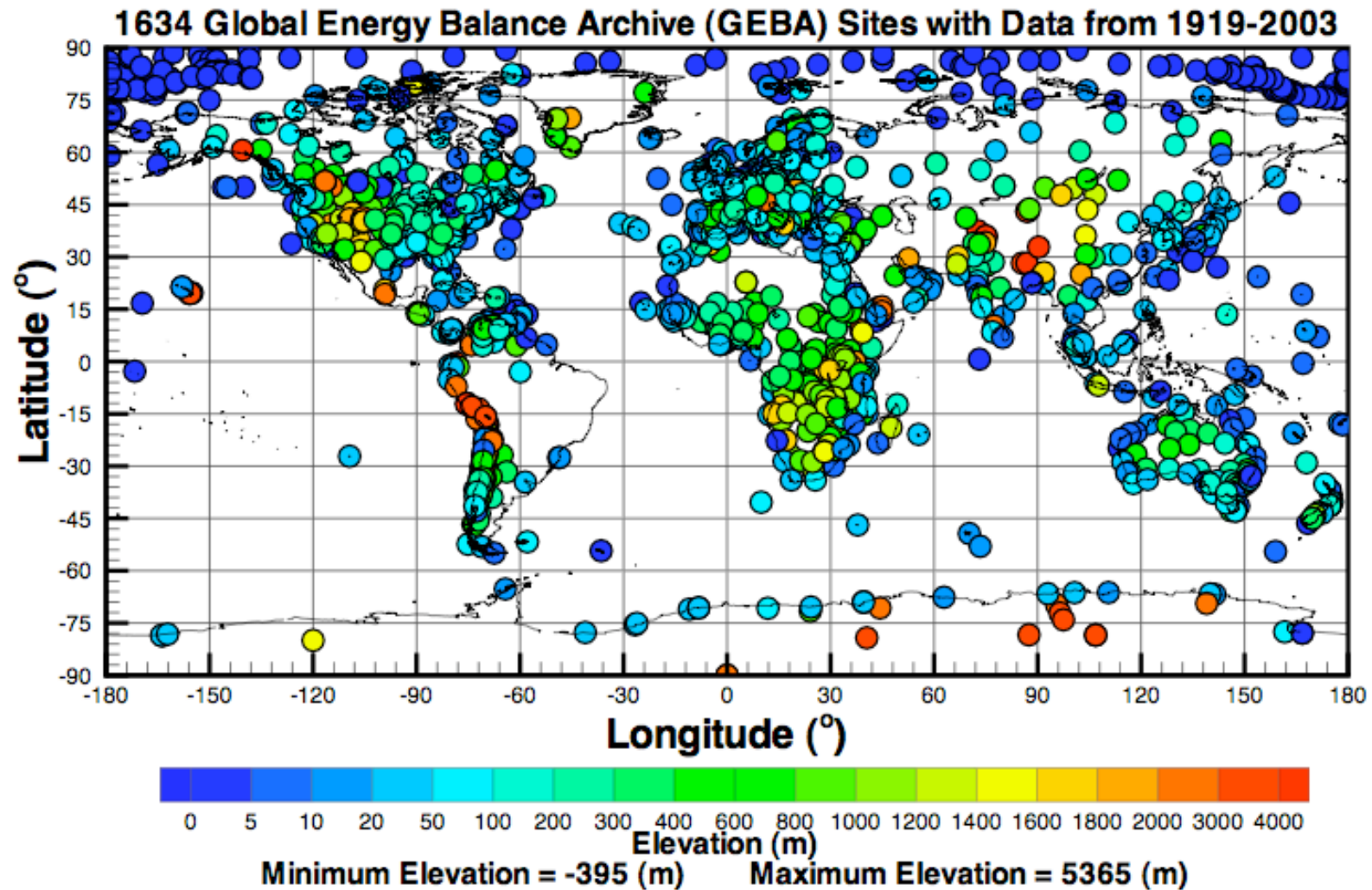
A project of the World Climate Programme

**Database of monthly mean fluxes measured
at the surface**

Over 3000 stations

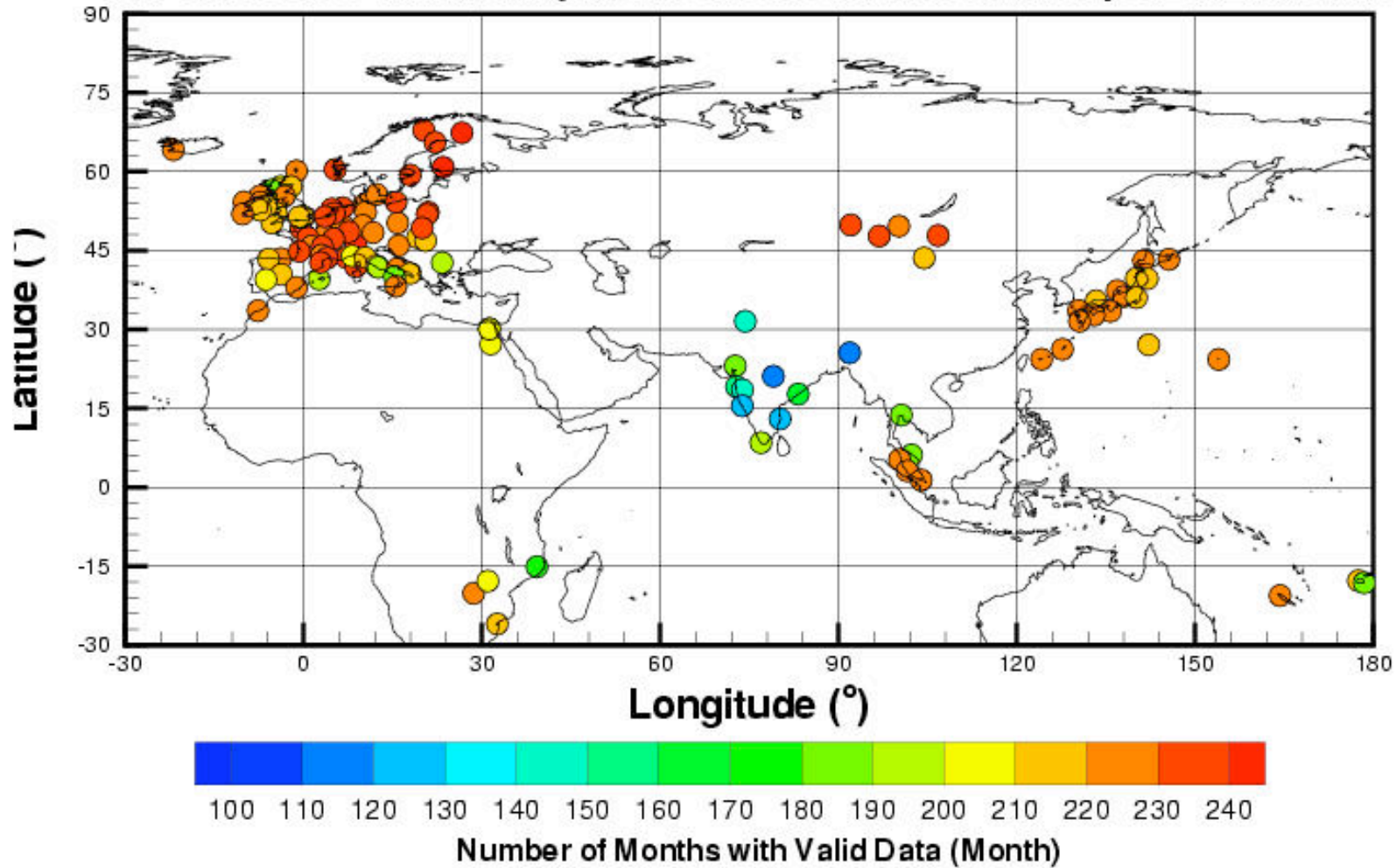
Oldest data goes back to 1919

Available GEBA Data

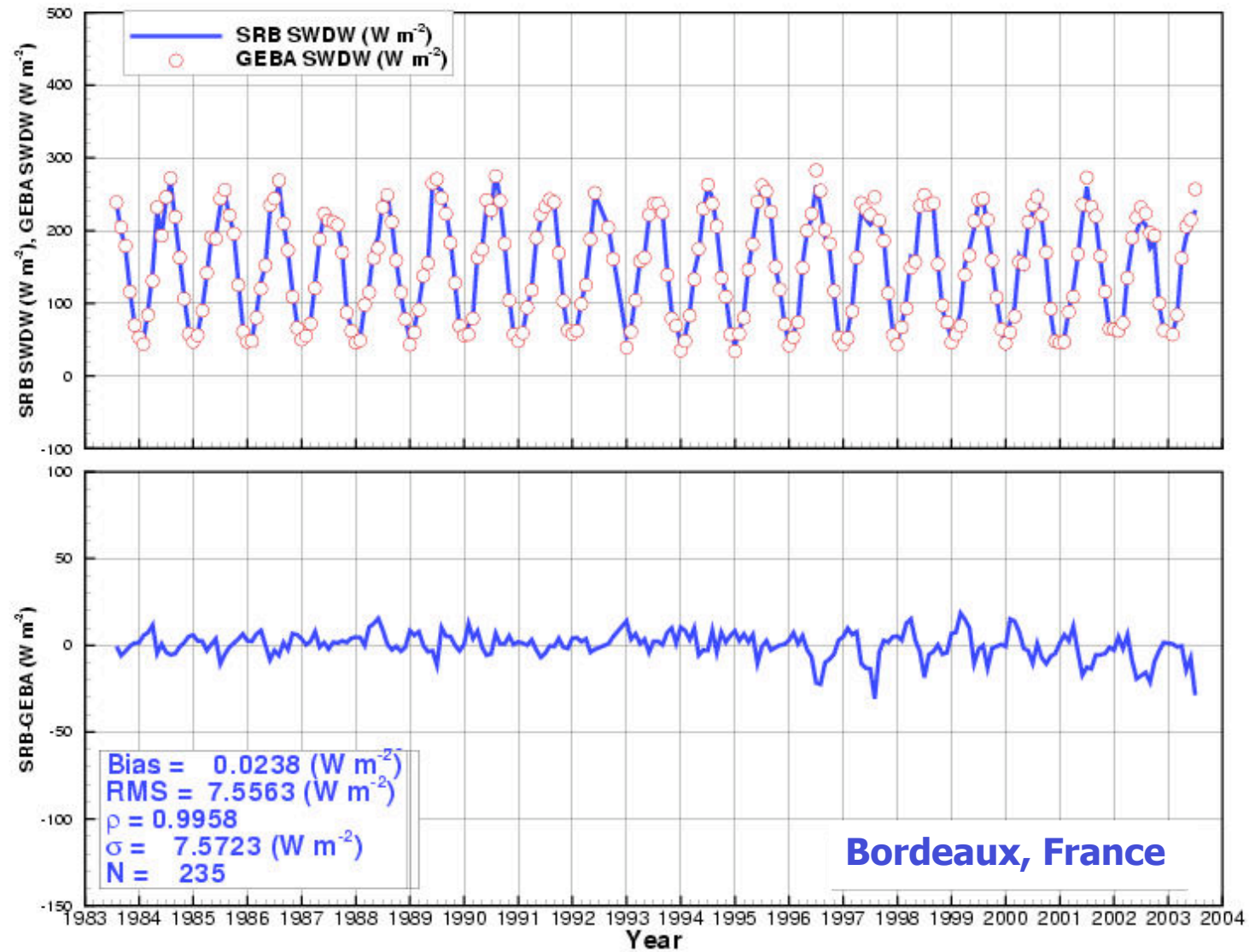


Available GEBA Data for 7/83-6/03

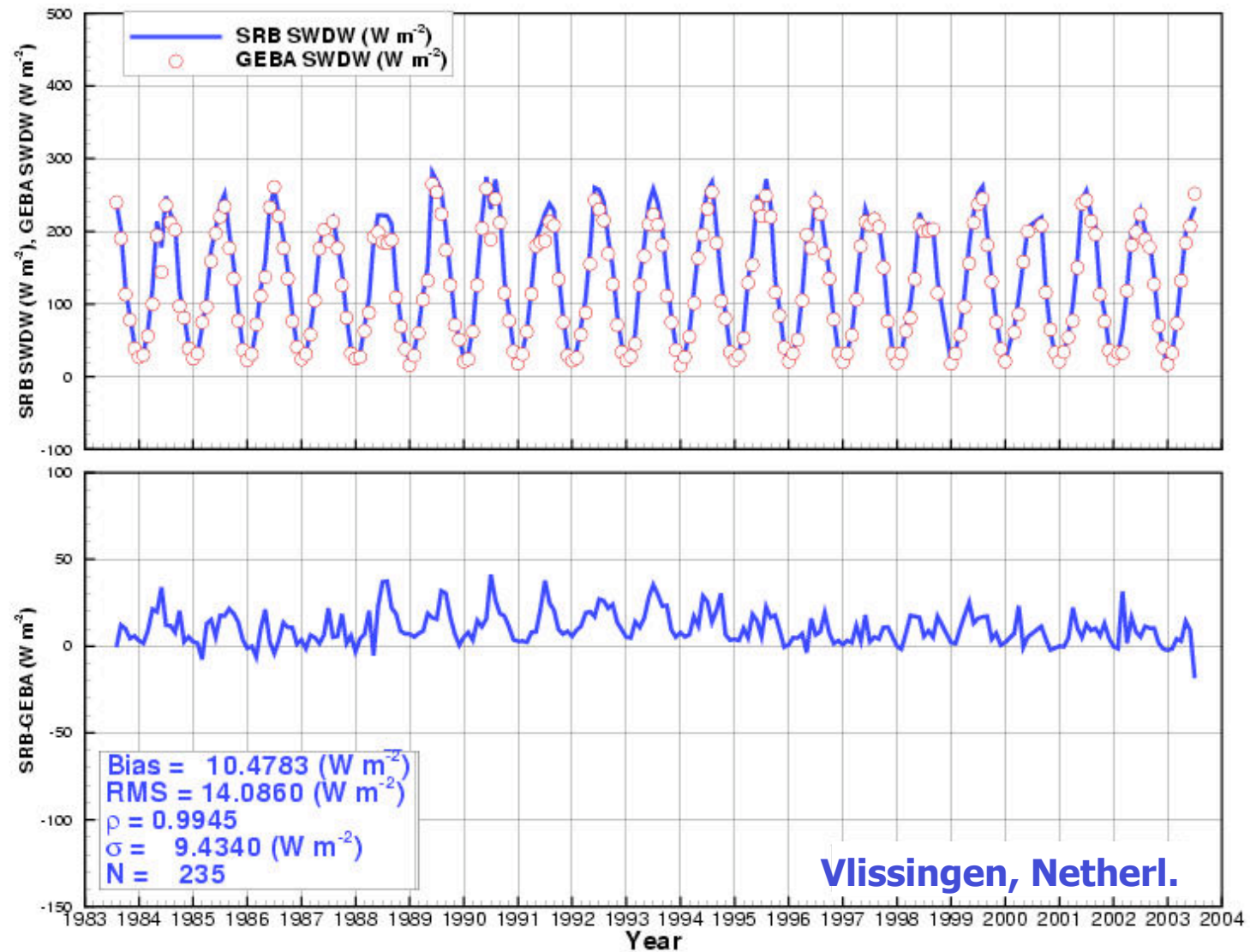
121 GEBA Sites with Monthly Means of SWDW Fluxes with Gaps .LE. 24 Months



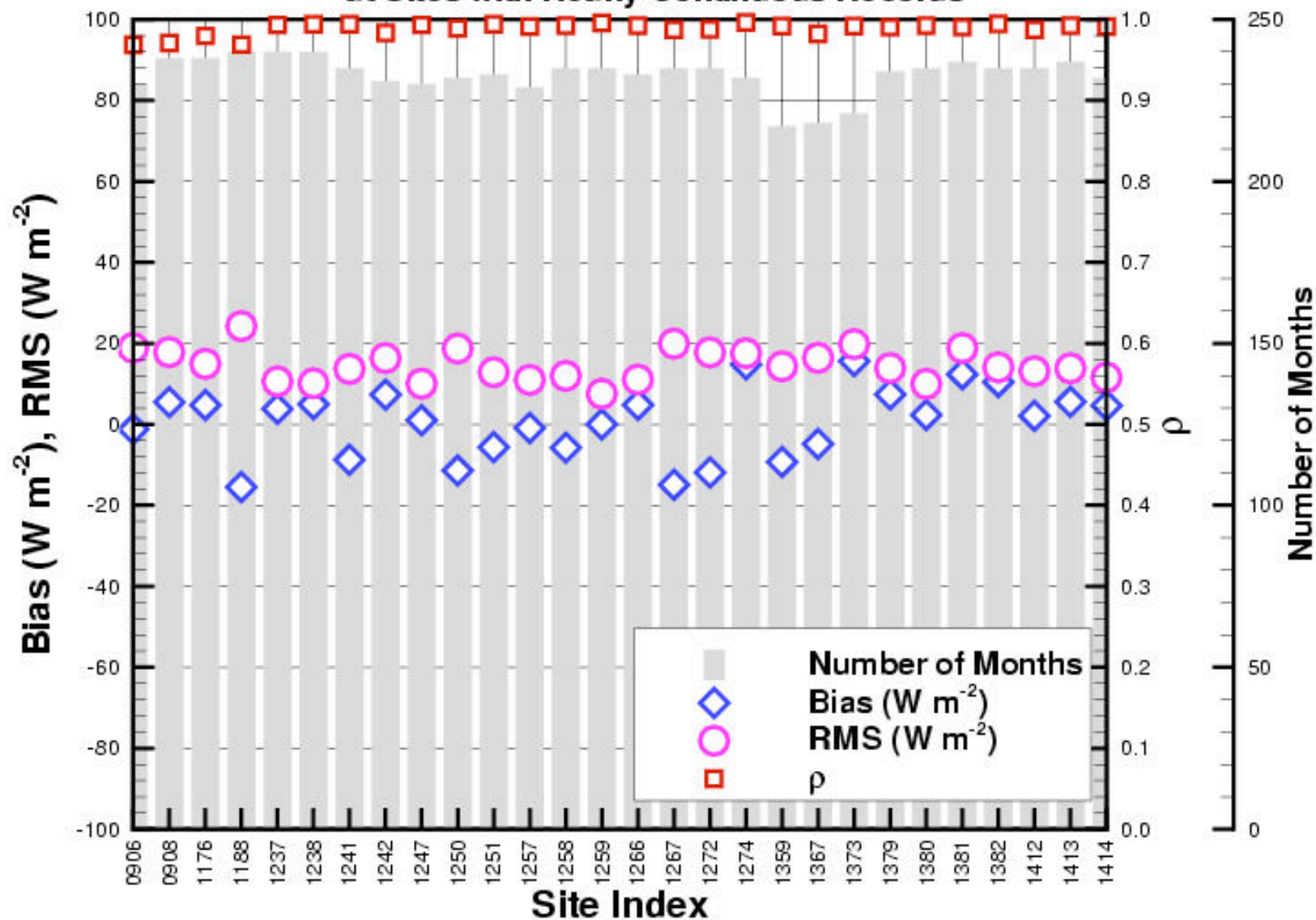
GEBA vs. GEWEX-SRB 2.5 Data



GEBA vs. GEWEX-SRB 2.5 Data

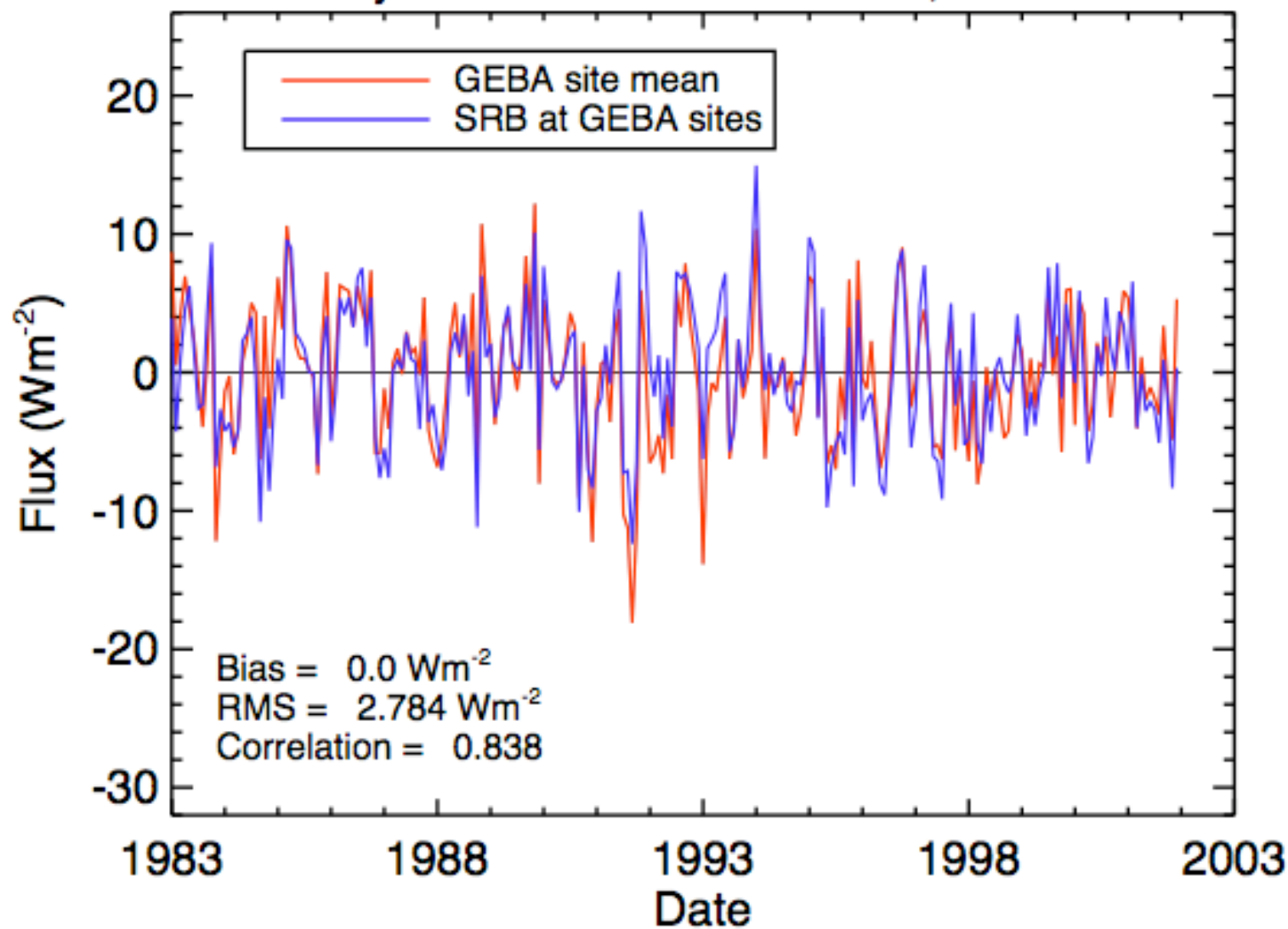


**Statistics of SRB(V2.5)-GEBA SWDW Monthly Mean Comparisons
for the Years 1983-07 to 2003-12 on A Site-by-Site Basis
at Sites with Nearly Continuous Records**



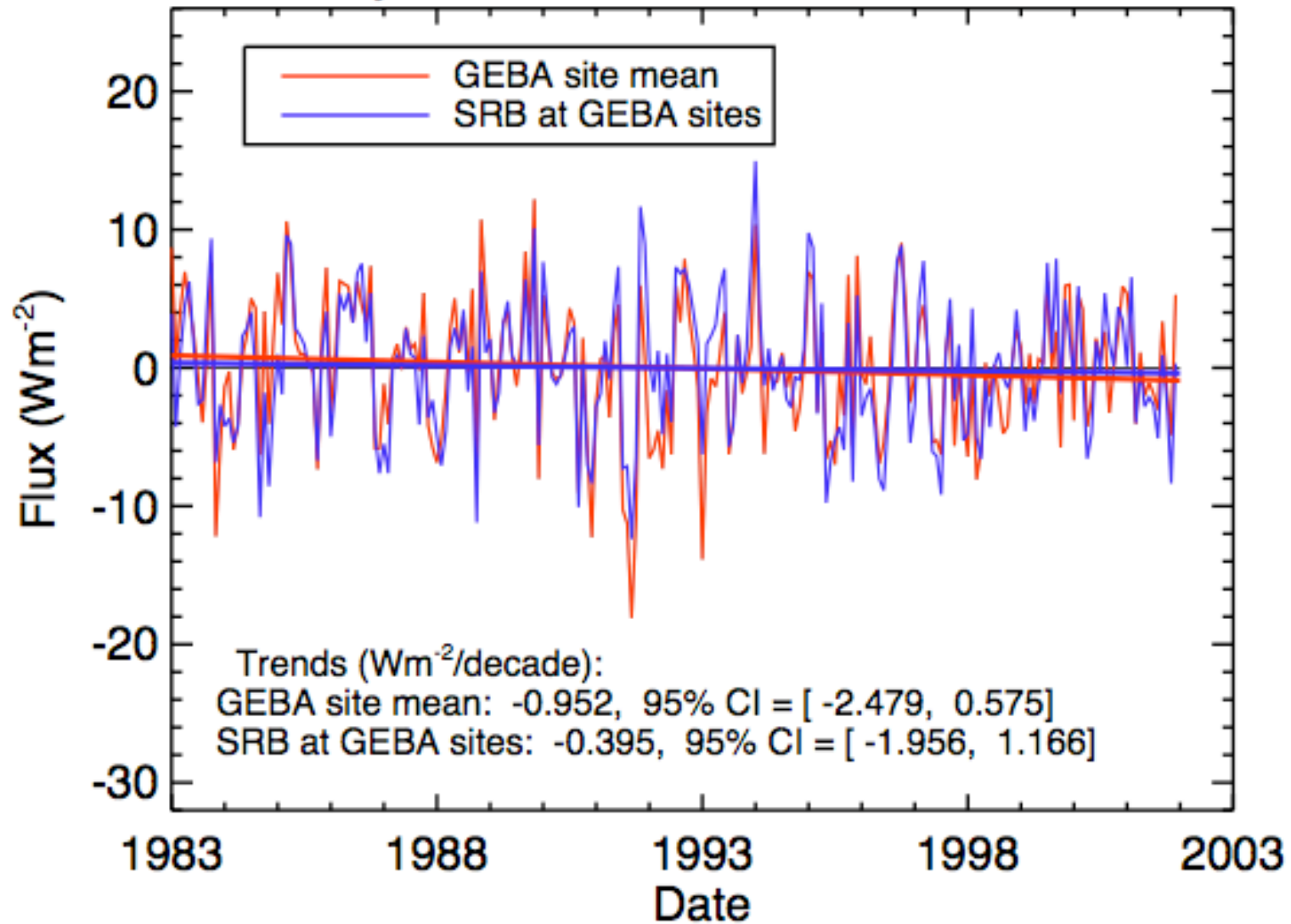
GEBA vs. GEWEX-SRB 2.5 Data

Monthly mean SW flux down at sfc, 1983-2002

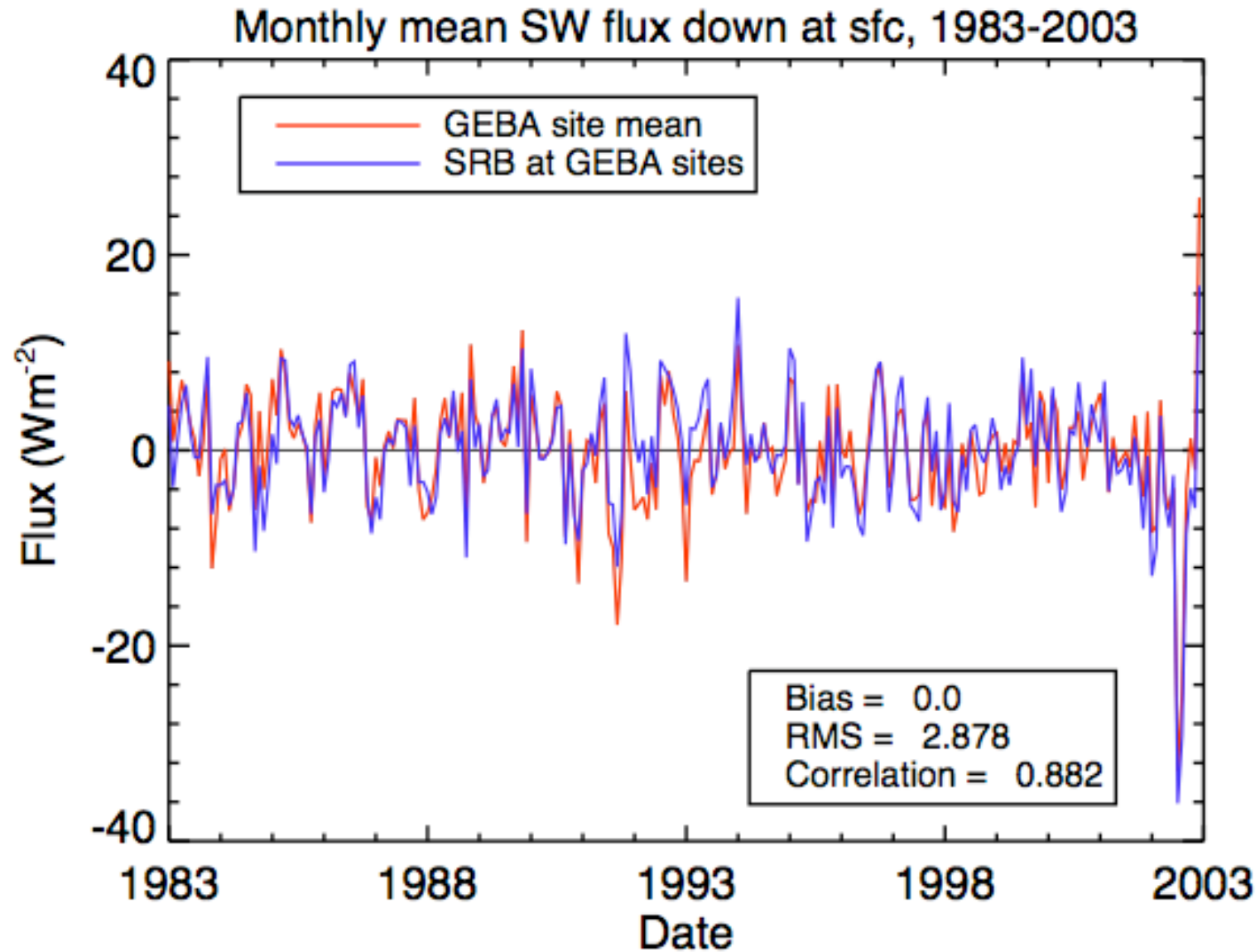


GEBA vs. GEWEX-SRB 2.5 Data

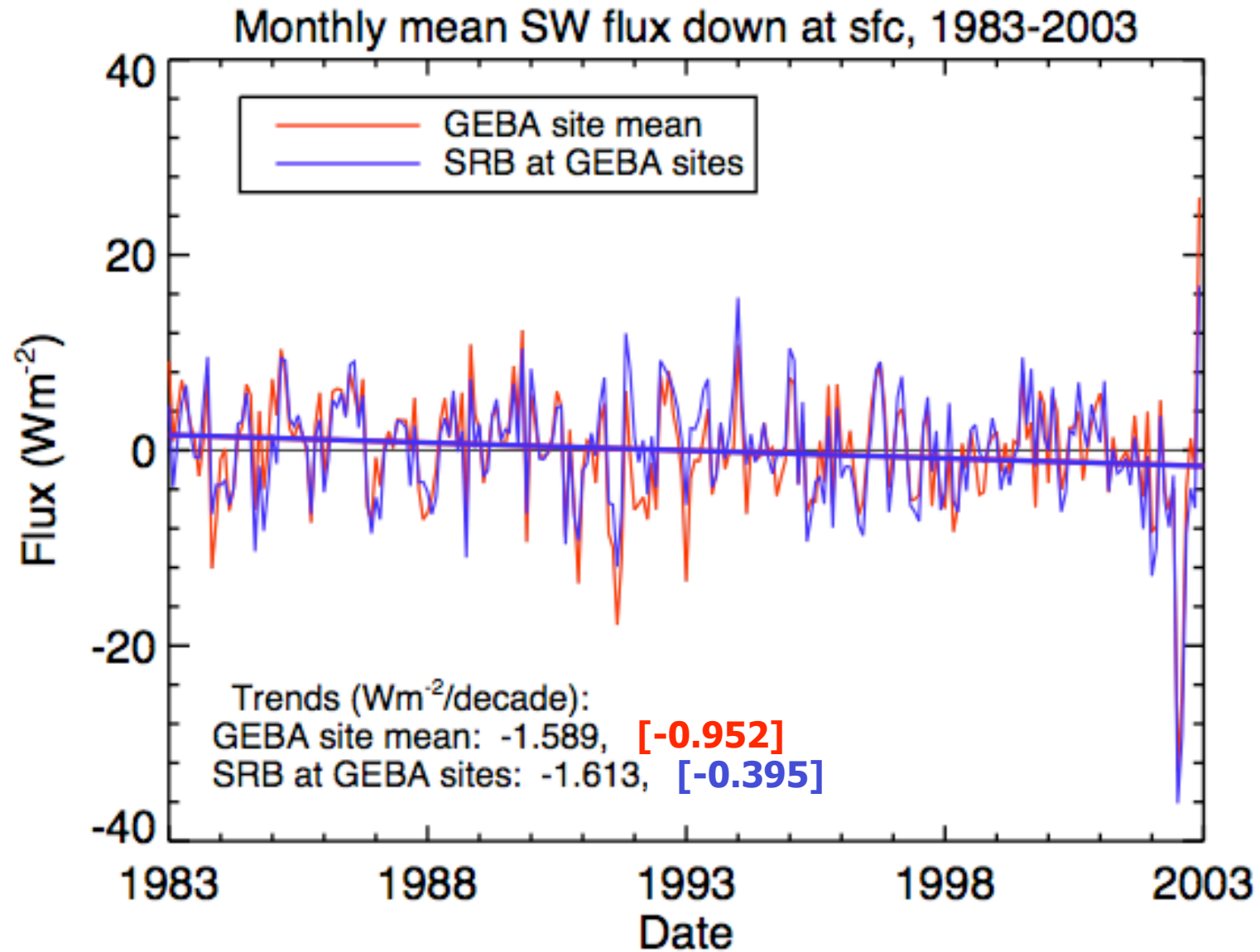
Monthly mean SW flux down at sfc, 1983-2002



GEBA vs. GEWEX-SRB 2.5 Data: 20 years



GEBA vs. GEWEX-SRB 2.5 Data: 20 years



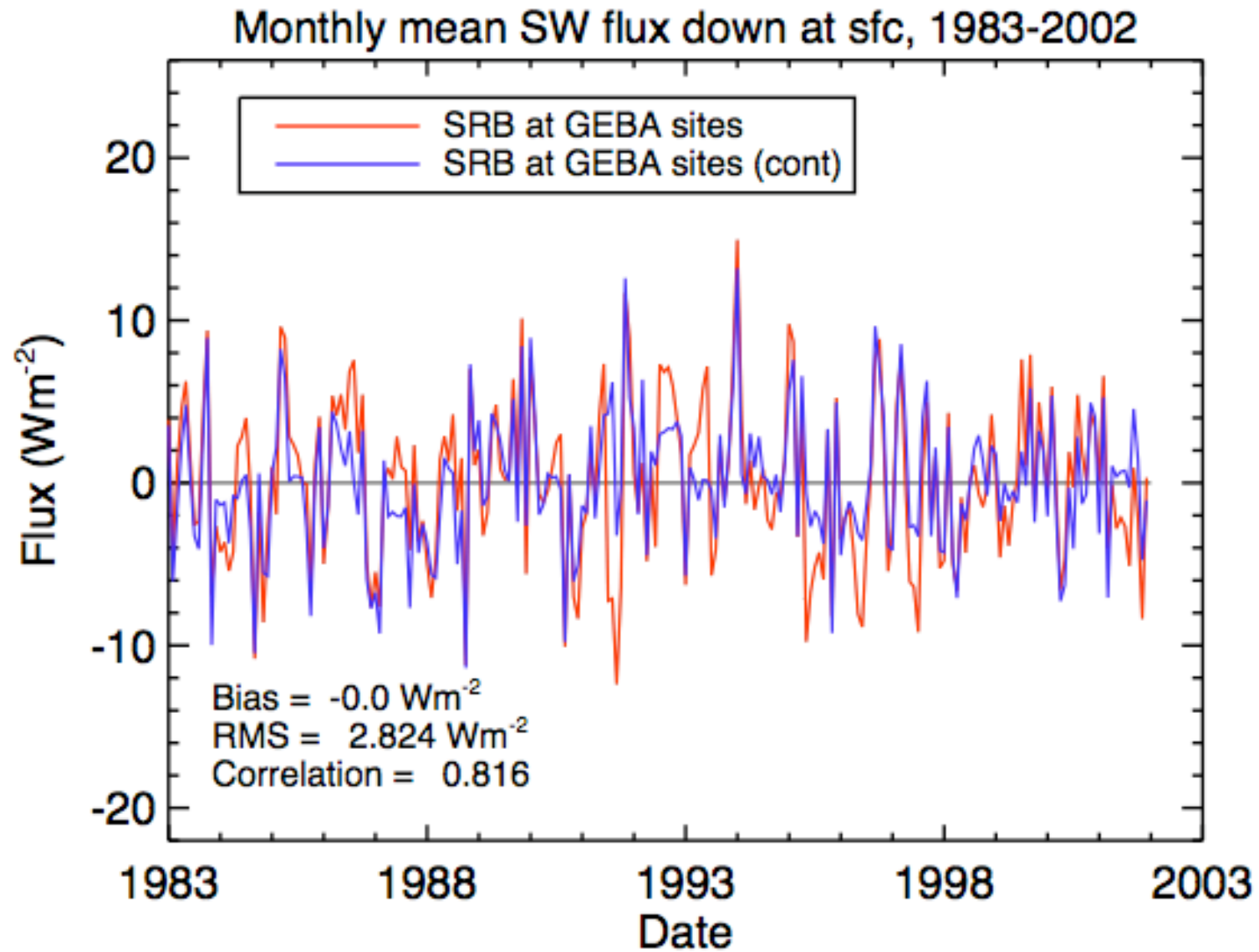
Results

GEBA and GEWEX SRB data quite similar.

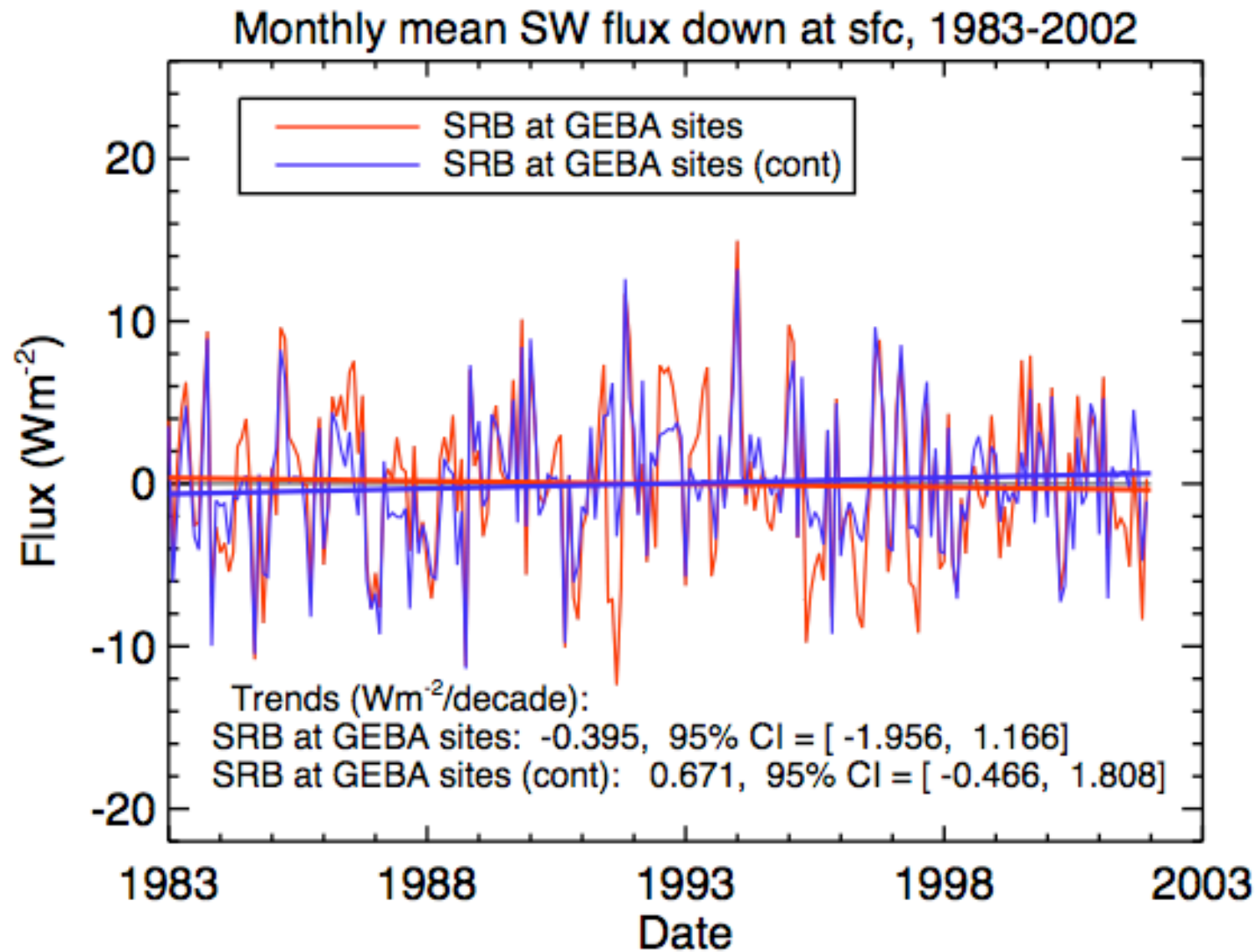
⇒ Use SRB as proxy for GEBA.

Compare trends as a function of sampling.

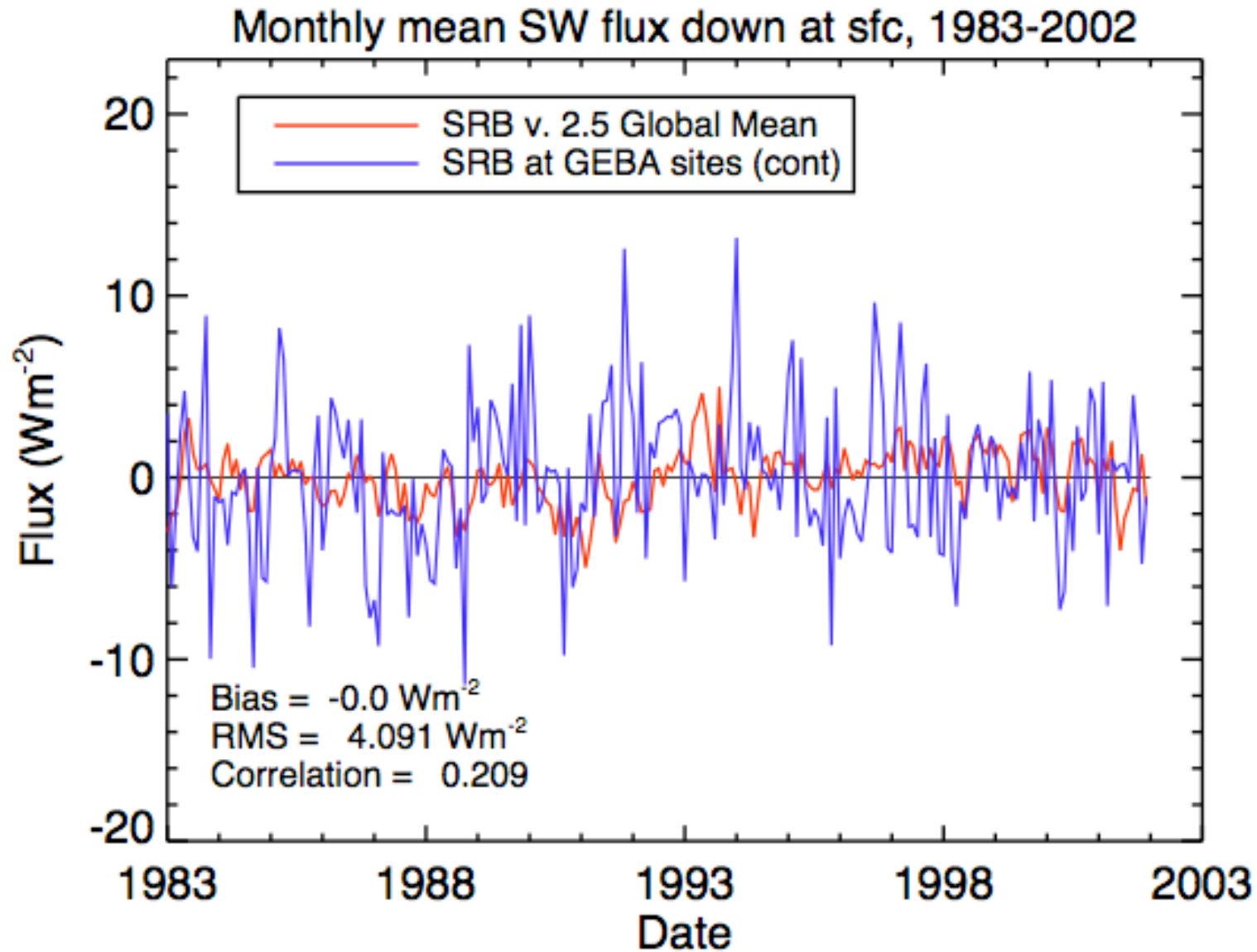
Effect of Gaps in Record



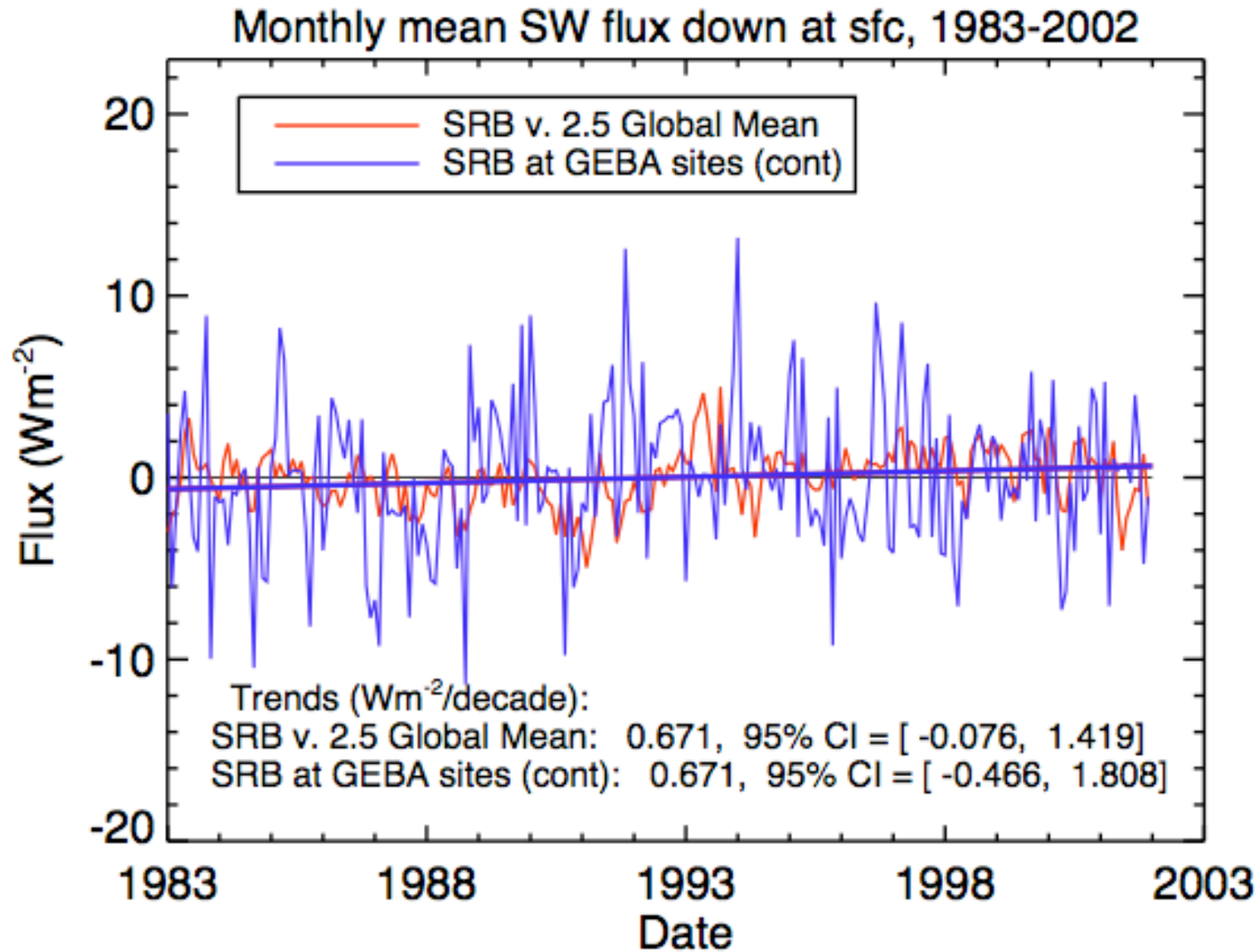
Effect of Gaps in Record



Global Mean vs. Site Data



Global Mean vs. Site Data



19-year Trends from GEBA and SRB Data

	Fitted slope	95% Confidence Interval	95% Sig. Time
GEBA data	-0.952	[-2.479, 0.575]	78.4
Matched SRB data	-0.395	[-1.956, 1.166]	79.8
SRB at GEBA sites	0.671	[-0.466, 1.808]	64.5
SRB global mean	0.671	[-0.076, 1.419]	48.7

Slopes and confidence intervals in $\text{Wm}^{-2}/\text{decade}$.

Sampling time for 95% significance assumes a trend of $0.3 \text{ Wm}^{-2}/\text{decade}$.

Values given in years.

19-year Trends from GEBA and SRB Data

	Fitted slope	95% Confidence Interval	95% Sig. Time	
GEBA data	-0.952	[-2.479, 0.575]	78.4	36.3
Matched SRB data	-0.395	[-1.956, 1.166]	79.8	66.3
SRB at GEBA sites	0.671	[-0.466, 1.808]	64.5	37.7
SRB global mean	0.671	[-0.076, 1.419]	48.7	28.5

Slopes and confidence intervals in $\text{Wm}^{-2}/\text{decade}$.

First sampling time for 95% significance assumes a trend of $0.3 \text{ Wm}^{-2}/\text{decade}$.

Second is for actual detected trend. Values given in years.

19-year Trends from GEBA and SRB Data

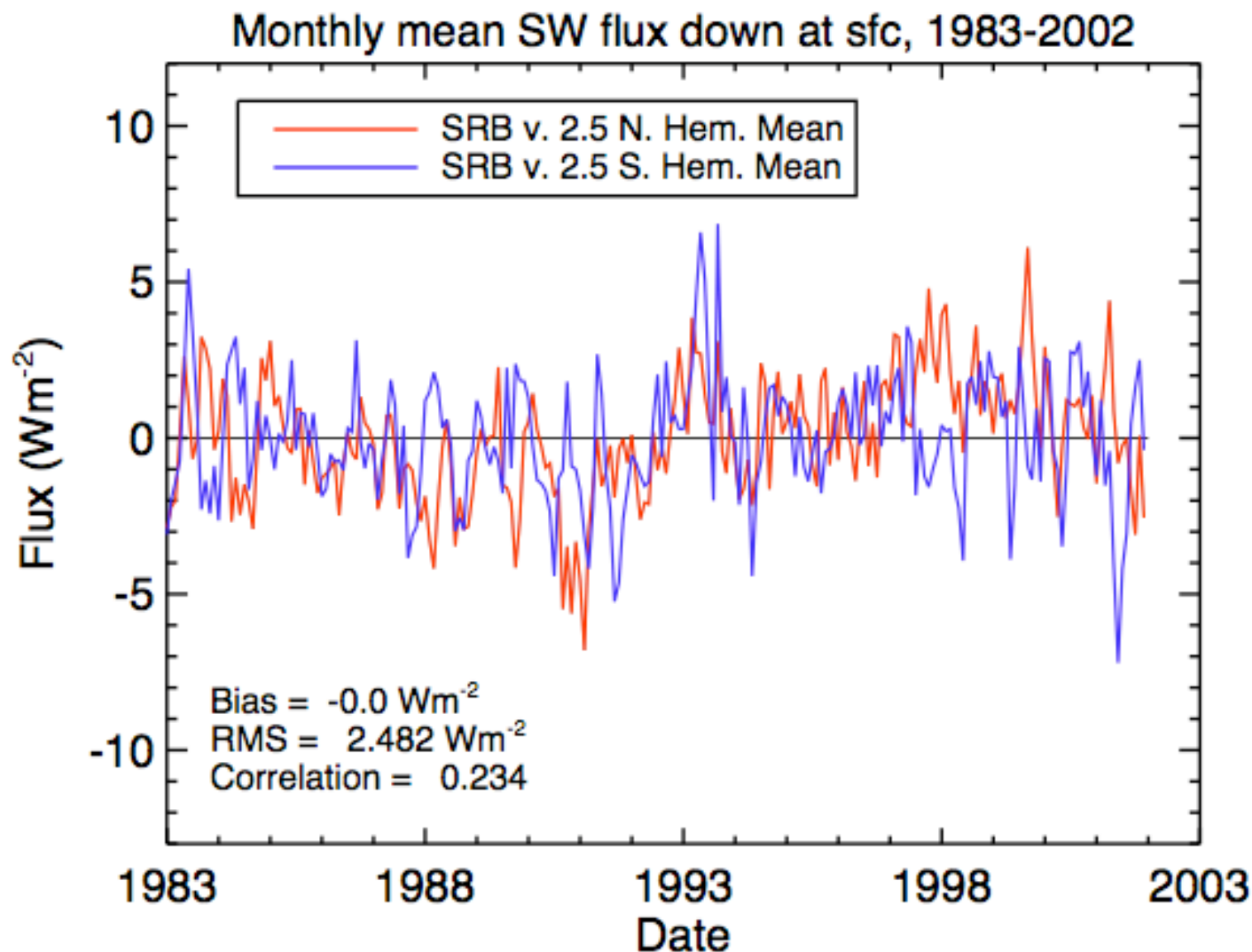
Non-Deseasonalized Data				
	Fitted slope	95% Confidence Interval	95% Sig. Time	
GEBA data	-0.264	[-48.138 , 47.611]	780.7	850.9
Matched SRB data	0.297	[-48.615, 49.209]	791.9	796.4
Deseasonalized Data				
	Fitted slope	95% Confidence Interval	95% Sig. Time	
GEBA data	-0.952	[-2.479, 0.575]	78.4	36.3
Matched SRB data	-0.395	[-1.956, 1.166]	79.8	66.3
SRB at GEBA sites	0.671	[-0.466, 1.808]	64.5	37.7
SRB global mean	0.671	[-0.076, 1.419]	48.7	28.5

Slopes and confidence intervals in $\text{Wm}^{-2}/\text{decade}$.

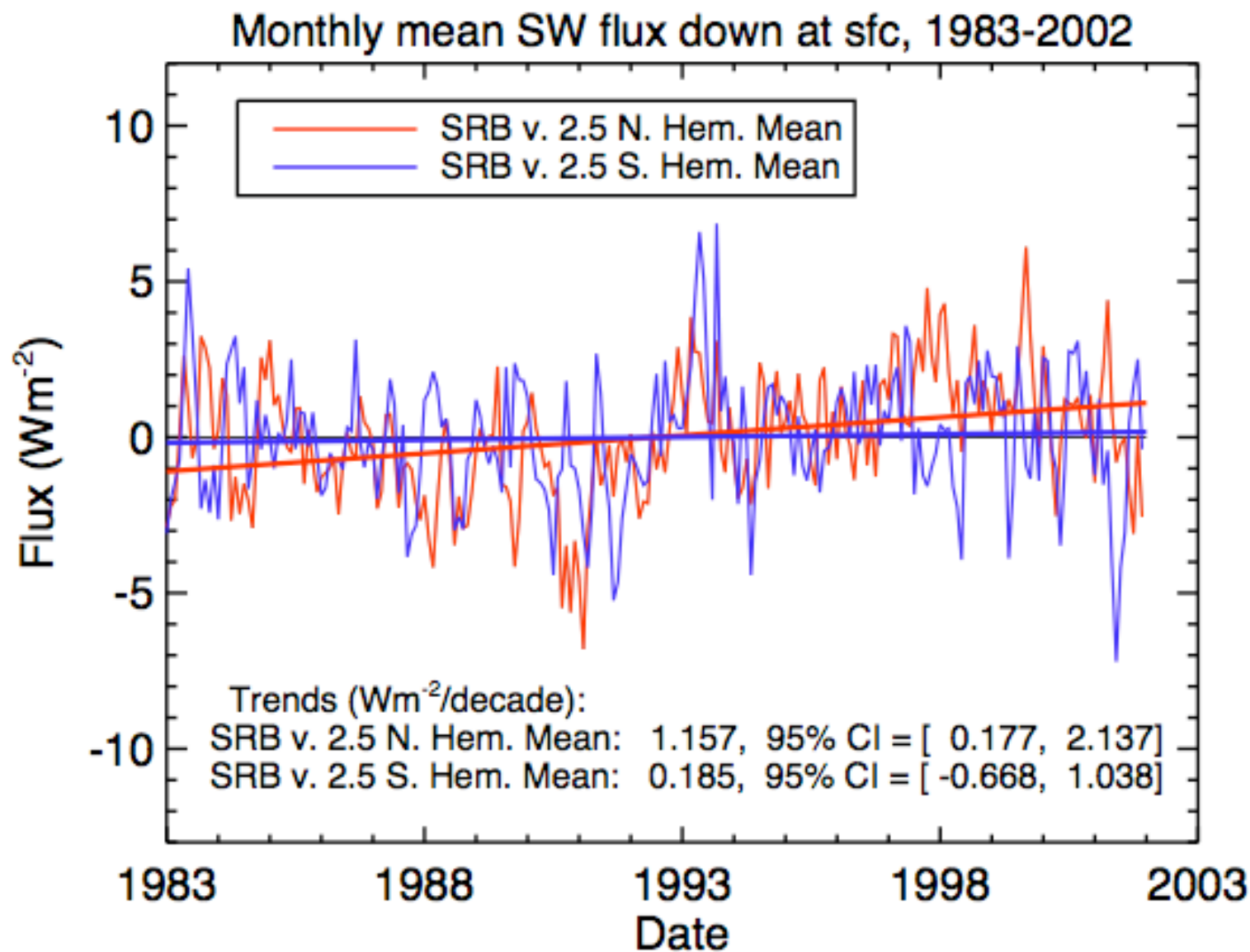
First sampling time for 95% significance assumes a trend of $0.3 \text{ Wm}^{-2}/\text{decade}$.

Second is for actual detected trend. Values given in years.

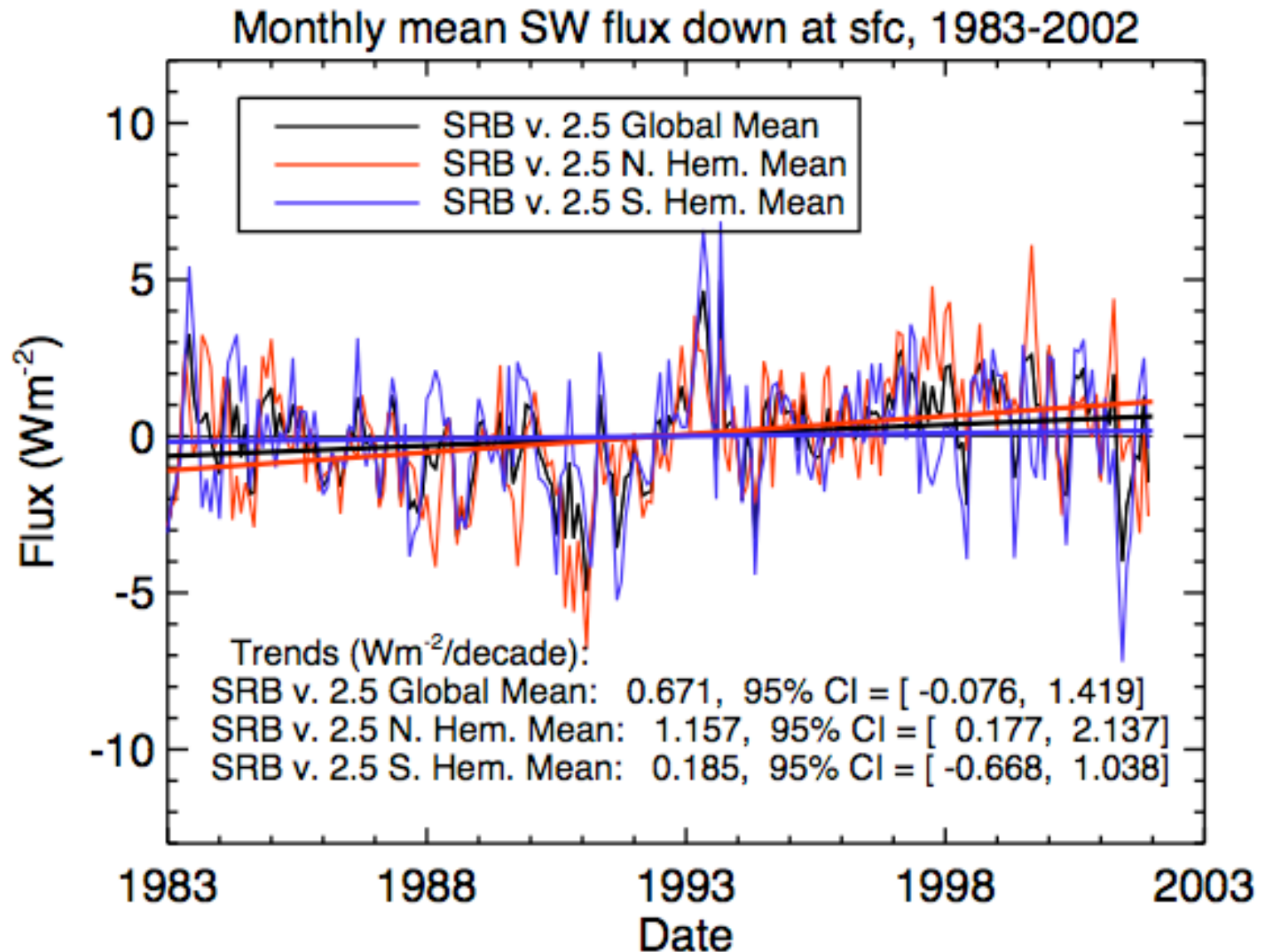
GEWEX-SRB Hemispheric Data



GEWEX-SRB Hemispheric Data



GEWEX-SRB Global and Hemispheric Data



19-year Trends from GEBA and SRB Data

	Fitted slope	95% Confidence Interval	95% Sig. Time	
GEBA data	-0.952	[-2.479, 0.575]	78.4	36.3
Matched SRB data	-0.395	[-1.956, 1.166]	79.8	66.3
SRB at GEBA sites	0.671	[-0.466, 1.808]	64.5	37.7
SRB global mean	0.671	[-0.076, 1.419]	48.7	28.5
SRB NH mean	1.157	[0.177, 2.137]	58.5	23.7
SRB SH mean	0.185	[-0.668, 1.038]	52.9	73.5

Slopes and confidence intervals in $\text{Wm}^{-2}/\text{decade}$.

First sampling time for 95% significance assumes a trend of $0.3 \text{ Wm}^{-2}/\text{decade}$.
Second is for actual detected trend. Values given in years.

Conclusions

Surface flux trends detected over current satellite record are nearing the level of significance.

End points of series strongly influence linear fit.

Data gaps degrade time series quality.

Sampling over a larger region improves noise but may also affect magnitude of trend.

Need to reduce noise, lengthen record to improve detection of long-term trends.

Future Plans

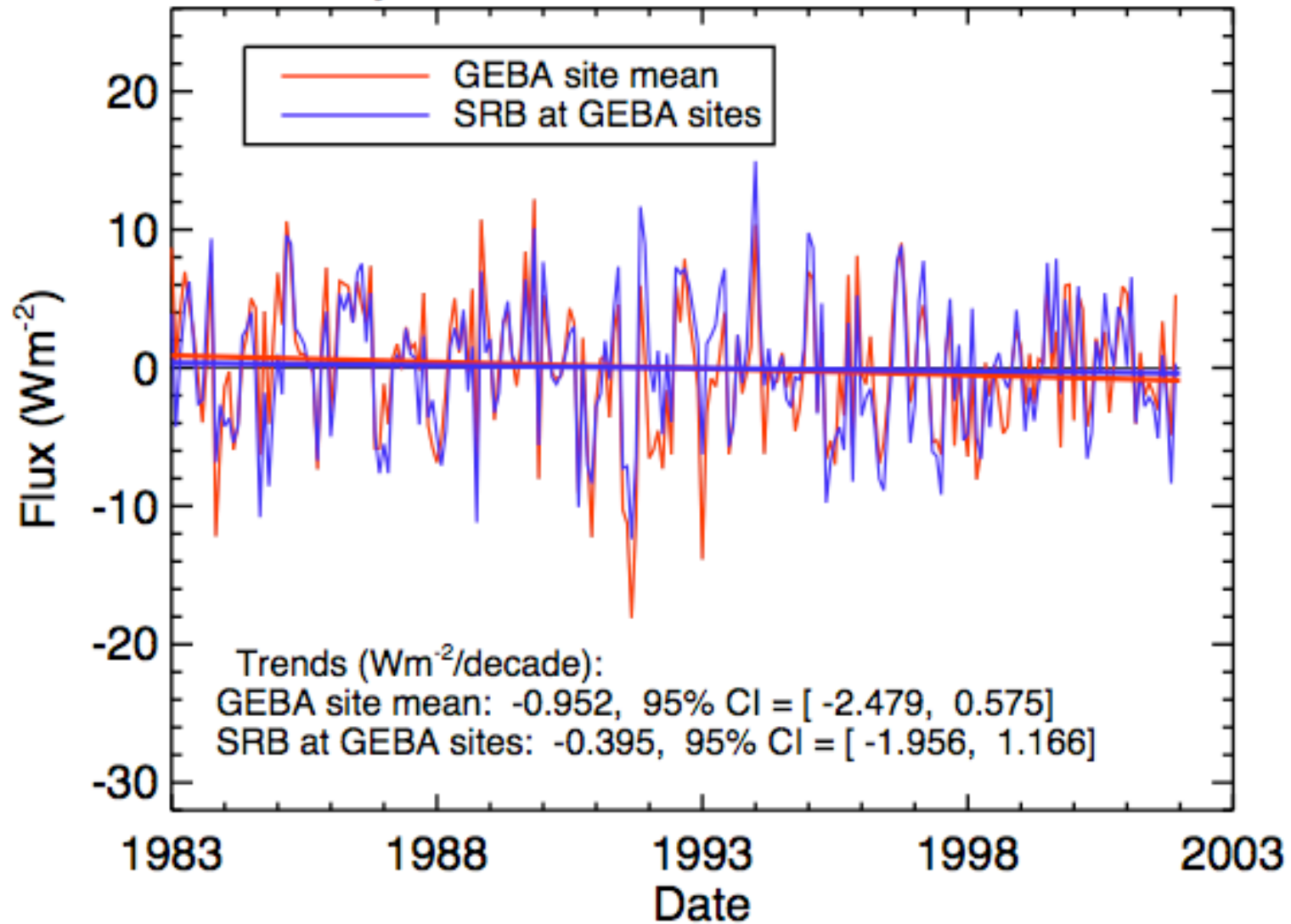
Seek optimum distribution of sites for trend detection.

Investigate representativeness of individual sites.

Compare trends from various satellite data sets.

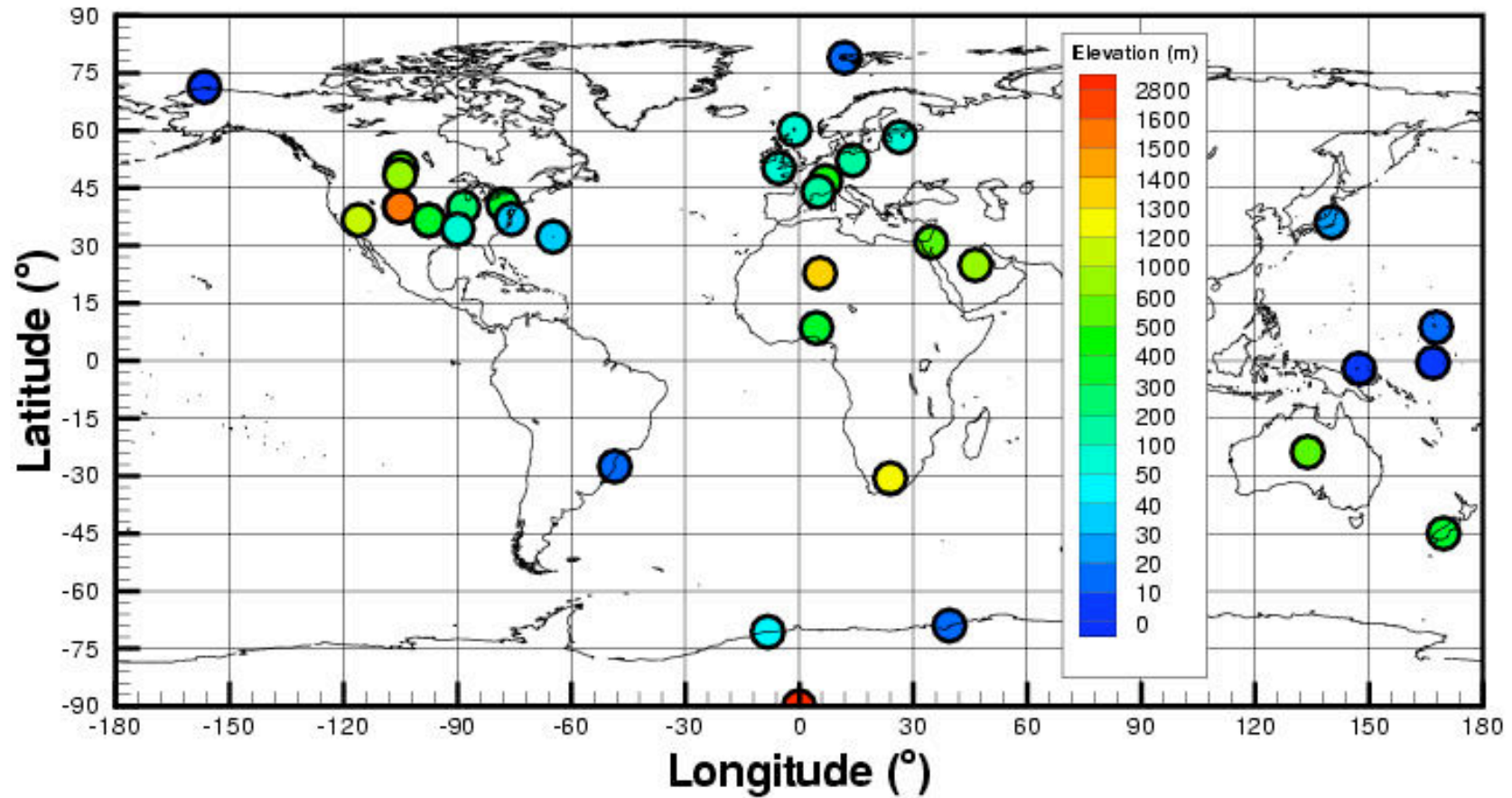
GEBA vs. GEWEX-SRB 2.5 Data

Monthly mean SW flux down at sfc, 1983-2002



BSRN Sites

Baseline Surface Radiation Network (BSRN) Sites with Data



Global Energy Balance Archive (GEBA)

**A project of the World Climate Programme
Database of monthly mean fluxes measured
at the surface**

Over 3000 stations

Oldest data goes back to 1919

19-year Trends from GEBA and SRB Data

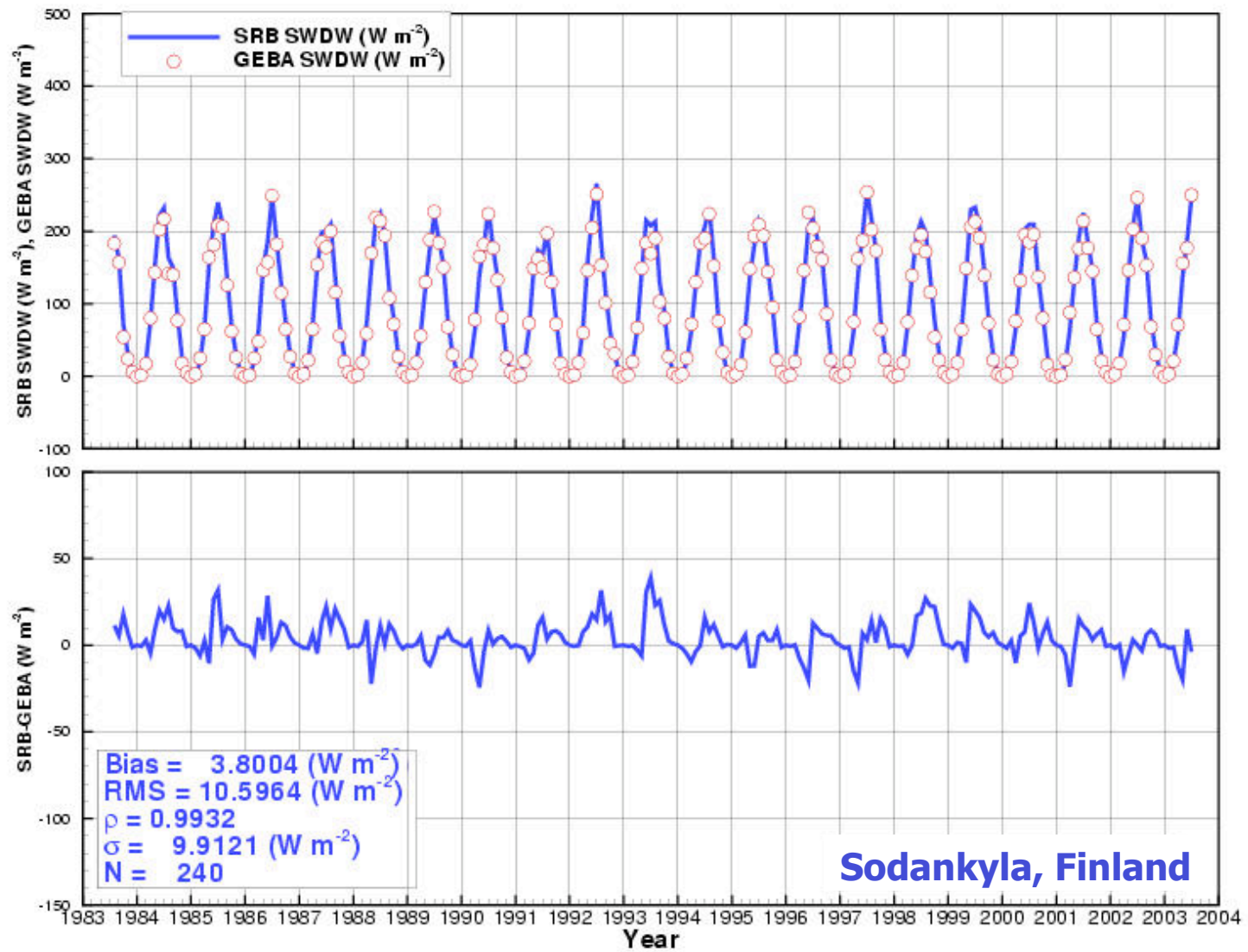
Non-Deseasonalized Data			
	Fitted slope	95% Confidence Interval	95% Sig. Time
GEBA data	-0.264	[-48.138 , 47.611]	168.2
Matched SRB data	0.297	[-48.615, 49.209]	170.6
Deseasonalized Data			
	Fitted slope	95% Confidence Interval	95% Sig. Time
GEBA data	-0.952	[-2.479, 0.575]	16.9
Matched SRB data	-0.395	[-1.956, 1.166]	17.2
SRB at GEBA sites	0.671	[-0.466, 1.808]	13.9
SRB global mean	0.671	[-0.076, 1.419]	10.5

Slopes and confidence intervals in $\text{Wm}^{-2}/\text{decade}$.

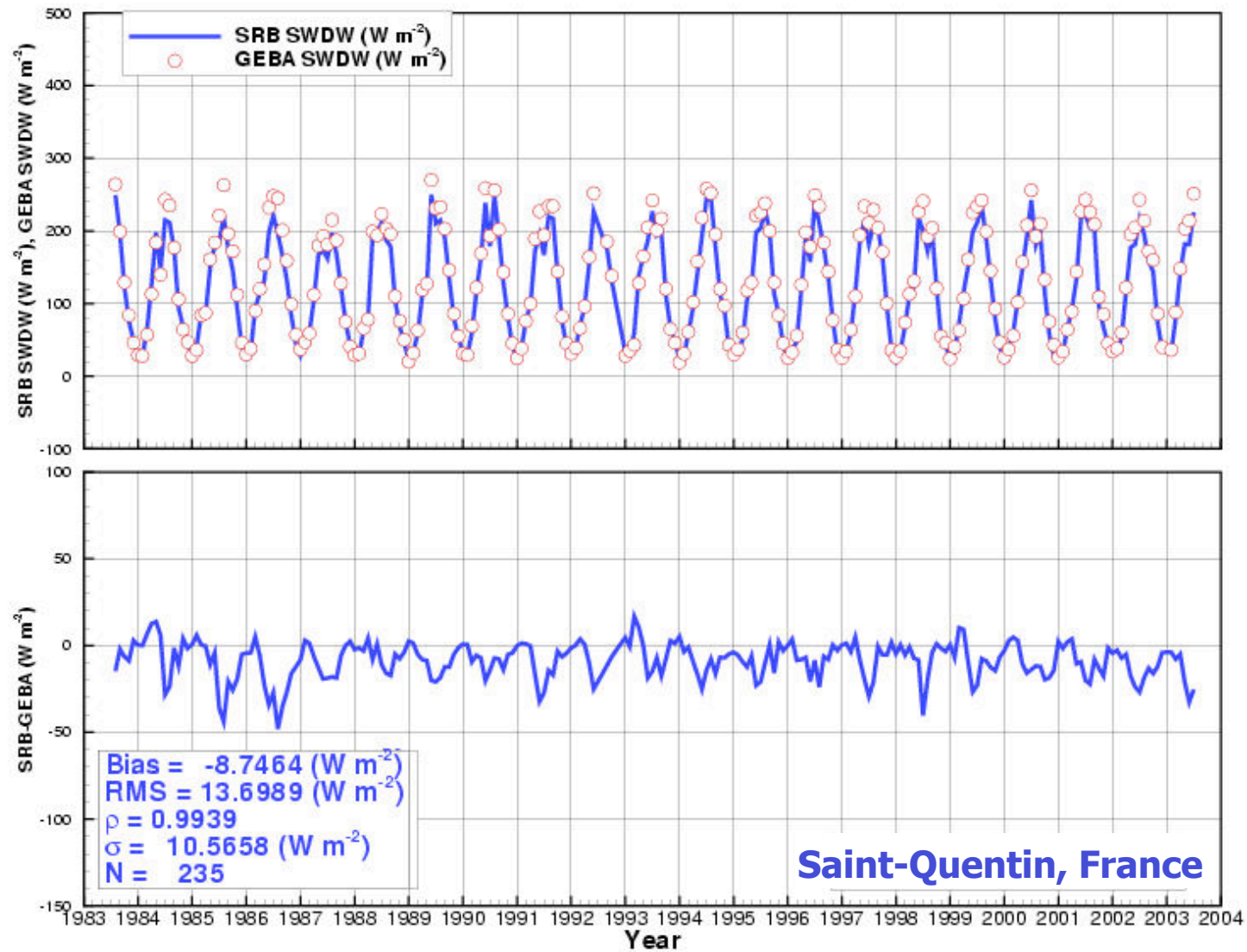
Sampling time for 95% significance assumes a trend of $0.3 \text{ Wm}^{-2}/\text{decade}$.

Values given in years.

Available GEBA Data



Available GEBA Data



20-year Trends from GEBA and SRB Data

Non-Deseasonalized Data			
	Fitted slope	95% Confidence Interval	95% Sig. Time
GEBA data	-0.950	[-45.559 , 43.658]	363.4
Matched SRB data	-0.978	[-46.487, 44.531]	361.3
Deseasonalized Data			
	Fitted slope	95% Confidence Interval	95% Sig. Time
GEBA data	-1.589	[-3.393, 0.215]	30.4
Matched SRB data	-1.614	[-3.552, 0.325]	31.6
SRB at GEBA sites	0.454	[-0.632, 1.540]	50.0
SRB global mean	0.447	[-0.247, 1.140]	37.4

Slopes and confidence intervals in $\text{Wm}^{-2}/\text{decade}$.
 Sampling duration for 95% significance in years.

19-year Trends from GEBA and SRB Data

	Fitted slope	95% Confidence Interval	95% Sig. Time
GEBA data	-0.952	[-2.479, 0.575]	78.4
Matched SRB data	-0.395	[-1.956, 1.166]	79.8
SRB at GEBA sites	0.671	[-0.466, 1.808]	64.5
SRB global mean	0.671	[-0.076, 1.419]	48.7
SRB NH mean	1.157	[0.177, 2.137]	58.5
SRB SH mean	0.185	[-0.668, 1.038]	52.9

Slopes and confidence intervals in $\text{Wm}^{-2}/\text{decade}$.
Sampling duration for 95% significance in years.